

Seat No:

Faculty of Natural Sciences
Department of Chemistry

Qualifications	:	ANCDIP/CHENDI	Date	:	31 May 2023
Subject	:	Engineering/Chemistry I	Venue	:	Bozzoli Hall
Subject Code	:	CHMS101/CHEM112	Time	:	9h00
Total Marks	:	113	Duration	:	3 hours
Full Marks	:	110	Examiner/s	:	Mr F.M Makhanya
Number of Pages	:	12	Moderator	:	Dr L.Q Qwabe
Annexure	:	1			

Student Name : -----

Student's Signature : -----

Student Number : -----

Examiner's Signature : -----

Moderator's Signature : -----

For office use only:

Question Number	1	2	3	4	5	6	7	8	Total Marks	Percentage (%)
Examiner's Mark										
Moderator's Mark										

INSTRUCTIONS TO STUDENTS:

1. Answer all questions.
2. Write all answers in the answer book or question paper provided.
3. Non-programmable calculators may be used.
4. Answer all questions in ink.

Question 1

Multiple Choice Questions

[14 Marks]

1.1 Which of the following concerning solutions is/are correct?

[2]

1. The solvent in a mixture of gases is generally considered to be the substance in greater amount.
 2. The solid dissolved in a solution is known as the solute.
 3. Solid solutions are called alloys.
- a. 1 only
 - b. 2 only
 - c. 3 only
 - d. 1 and 2
 - e. 1, 2, and 3

1.2 The following representation of an atom is called

[2]



- a. a Lewis dot structure.
- b. an ion.
- c. a structural formula.
- d. an electrostatic potential map.
- e. an ionic bond.

1.3 Which of the following statements is/are consistent with the Arrhenius concept of acids and bases?

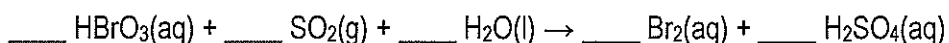
[2]

1. An Arrhenius acid will increase the concentration of hydronium ion in an aqueous or nonaqueous solvent.
 2. All Arrhenius acids are strong electrolytes in water.
 3. All strong acid-strong base reactions have the same heat of reaction (ΔH°) per mole of water formed.
- a. 1 only
 - b. 2 only
 - c. 3 only
 - d. 1 and 3
 - e. 1, 2 and 3

1.4 Which of the following is a weak base in aqueous solution ? [2]

- a. $\text{HOCH}_2\text{CH}_2\text{OH}$
- b. $\text{Ba}(\text{OH})_2$
- c. CH_3COOH
- d. NH_3
- e. HBr

1.5 When the following equation is balanced, what is the lowest whole-number coefficient for SO_2 ? [2]



- a. 7
- b. 10
- c. 8
- d. 4
- e. 5

1.6 A particular gas exerts a pressure of $4.09 \times 10^4 \text{ Pa}$. [2]

What is this pressure in units of atmospheres?

- a. 0.403 atm
- b. $4.04 \times 10^9 \text{ atm}$
- c. 0.414 atm
- d. 0.409 atm
- e. $4.14 \times 10^9 \text{ atm}$

1.7 Which of the following is a correct statement of Charles's law, $\frac{V}{T} = k$? [2]

- a. The volume of a gas varies proportionally with the pressure.
- b. The volume of a gas sample varies directly with the absolute temperature.
- c. All gas samples of the same volume at STP contain the same number of atoms.
- d. The pressure of a gas sample varies inversely with the volume.
- e. All gas samples of the same volume at STP contain the same number of molecules.

Question 2

Definitions

[16 Marks]

2.1 What is the law of conservation of mass ? [2]

2.2 Define the Pauli exclusion principle [2]

2.3 What is Hund's rule [2]

2.4 Define a Polyatomic ion [2]

2.5 What is a metathesis reaction [2]

2.6 Define a Brønsted acid [2]

2.7 What is Stoichiometry [2]

2.8 Define a miscible fluid [2]

Question 3 Elements, Atoms, Molecules and Ions**[10 Marks]**

3.1 Draw a basic representation of an atom

[5]

3.2 Chromium, Cr, has the following isotopic masses and fractional abundances:
What is the atomic weight of chromium?

[5]

<i>Mass Number</i>	<i>Isotopic Mass (amu)</i>	<i>Fractional Abundance</i>
50	49.9461	0.0435
52	51.9405	0.8379
53	52.9407	0.0950
54	53.9389	0.0236

Question 4 Chemical bonding and Nomenclature [15 Marks]

4.1 Show a Lewis dot coordinate covalent bond of the formation of the ammonium ion [5]

4.2 Write chemical names/formulas for the following compounds: [10]

4.2.1 Cl_2O_7 -

4.2.2 $\text{HCN}(\text{aq})$ -

4.2.3 N_2O_5 -

4.2.4 HClO_3 -

4.2.5 ClO^- -

4.2.6 $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ -

4.2.7 NH_4Cl -

4.2.8 CH_3COONa -

4.2.9 Carbonic acid -

4.2.10 Calcium Sulphate Decahydrate -

Question 5**Types of Chemical Reactions****[32 Marks]**

5.1 For each of the following, decide whether a precipitation reaction occurs.

If it does, write the balanced molecular equation and then the net ionic equation.

- (a) Aqueous solutions of iron (II) chloride and silver nitrate are mixed. [6]
- (b) Aqueous solutions of magnesium chloride and iron (II) nitrate are mixed. [6]

5.2 Acid Base Reactions

- 5.2.1 Write the molecular equation and then the net ionic equation for the neutralization of nitrous acid, HNO_2 , by sodium hydroxide, NaOH , both in aqueous solution. [5]
Use an arrow with H^+ over it to show the proton transfer.

5.3 Oxidation Reduction Reactions

- 5.3.1 What is the oxidation state of Cr in (a) $\text{K}_2\text{Cr}_2\text{O}_7$ (b) CrO_3^- (7)

5.3.2 Write the balanced half-cell reactions and net ionic equation for the following [8]



Question 6**Chemical Composition and Solutions****[14 Marks]**

6.1 30 g of C_3H_8 burns in air to produce 70 g of CO_2 .

[8]

Calculate the theoretical yield and percent yield of CO_2

6.2 If you have 0.0015 g NaCl in a 2500g solution

6.2.1 What is the concentration in parts per million

[3]

6.2.2 Given 35000 g of a 210 ppm solution how many grams of salt are present

[3]

The Periodic Table of the Elements (with Electronegativities)

1

Hydrogen

1

H

1.01

2.1

2

Helium

2

He

4.00

—

3

Lithium

3

Li

6.94

1.0

4

Beryllium

4

Be

9.01

1.5

5

Boron

5

B

10.81

2.0

6

Carbon

6

C

12.01

2.5

7

Nitrogen

7

N

14.01

3.0

8

Oxygen

8

O

16.00

3.5

9

Fluorine

9

F

19.00

4.0

10

Neon

10

Ne

20.18

—

11

Sodium

11

Na

22.99

0.9

12

Magnesium

12

Mg

24.31

1.2

13

Aluminum

13

Al

26.98

1.5

14

Silicon

14

Si

28.09

1.8

15

Phosphorus

15

P

30.97

2.1

16

Sulfur

16

S

32.07

2.5

17

Chlorine

17

Cl

35.45

3.0

18

Argon

18

Ar

39.95

—

19

Potassium

19

K

39.10

0.8

20

Calcium

20

Ca

40.08

1.0

21

Scandium

21

Sc

44.96

1.3

22

Titanium

22

Ti

47.88

1.5

23

Vanadium

23

V

50.94

1.6

24

Chromium

24

Cr

52.00

1.6

25

Manganese

25

Mn

54.94

1.5

26

Iron

26

Fe

55.85

1.8

27

Cobalt

27

Co

58.93

1.8

28

Nickel

28

Ni

58.69

1.8

29

Copper

29

Cu

63.55

1.9

30

Zinc

30

Zn

65.39

1.6

31

Gallium

31

Ga

69.72

1.6

32

Germanium

32

Ge

72.61

1.8

33

Arsenic

33

As

74.92

2.0

34

Selenium

34

Se

78.96

2.4

35

Bromine

35

Br

79.90

2.8

36

Krypton

36

Kr

83.80

3.0

37

Rubidium

37

Rb

85.47

0.8

38

Strontium

38

Sr

87.62

1.0

39

Yttrium

39

Y

88.91

1.2

40

Zirconium

40

Zr

91.22

1.4

41

Niobium

41

Nb

92.91

1.6

42

Molybdenum

42

Mo

95.94

1.8

43

Technetium

43

Tc

(98)

1.9

44

Ruthenium

44

Ru

101.07

2.2

45

Rhodium

45

Rh

102.91

2.2

46

Palladium

46

Pd

106.42

2.2

47

Silver

47

Ag

107.87

1.9

48

Cadmium

48

Cd

112.41

1.7

49

Indium

49

In

114.82

1.7

50

Tin

50

Sn

118.71

1.8

51

Antimony

51

Sb

121.76

1.9

52

Tellurium

52

Te

127.60

2.1

53

Iodine

53

I

126.90

2.5

54

Xenon

54

Xe

131.29

2.6

55

Cesium

55

Cs

132.91

0.7

56

Barium

56

Ba

137.33

0.9

57-70

Lanthanum

71

Lu

174.97

1.1

71

Lu

71

Lu

174.97

1.1

72

Hafnium

72

Hf

178.49

1.3

73

Tantalum

73

Ta

180.95

1.5

74

Tungsten

74

W

183.84

1.7

75

Rhenium

75

Re

186.21

1.9

76

Osmium

76

Os

190.23

2.2

77

Iridium

77

Ir

192.22

2.2

78

Platinum

78

Pt

195.08

2.2

79

Gold

79

Au

196.97

2.4

80

Mercury

80

Hg

200.59

1.9

81

Thallium

81

Tl

204.38

1.8

82

Lead

82

Pb

207.20

1.8

83

Bismuth

83

Bi

208.98

1.9

84

Polonium

84

Po

(209)

2.0

85

Astatine

85

At

(210)

2.2

86

Radon

86

Rn

(222)

2.4

87

Francium

87

Fr

(223)

0.7

88

Radium

88

Ra

(226)

0.9

89-102

Lanthanum

103

Lr

(262)

—

103

Lr

103

Lr

(262)

—

104

Rutherfordium

104

Rf

(267)

—

105

Dubnium

105

Db

(268)

—

106

Seaborgium

106

Sg

(271)

—

107

Bohrium

107

Bh

(272)

—

108

Hassium

108

Hs

(270)

—

109

Mendelevium

109

Mt

(276)

—

110

Darmstadtium

110

Ds

(281)

—

111

Roentgenium

111

Rg

(280)

—

112

Copernicium

112

Cn

(285)

—

113

Ununtrium

113

Uut

(284)

—

114

Ununquadium

114

Uuq

(289)

—

115

Ununpentium

115

Uup

(288)

—

116

Ununhexium

116

Uuh

(293)

—

117

Ununseptium

117

Uus

(294?)

—

118

Ununoctium

118

Uuo

(294)

—

Element name

Symbol

Atomic #

Electronegativity

Avg. Mass

Mercury

80

Hg

200.59

1.9

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

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57-70

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86

87

88

89-102

103

104

105

106

107

108

109

110

111

112

113

114

115

116

117

118

*|anthanides

****actinides**

Lanthanum	Cerium	Praseodymium	Neodymium	Promethium	Samarium	Europium	Gadolinium	Terbium	Dysprosium	Holmium	Erbium	Thulium	Ytterbium
57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb
138.91 1.1	140.12 1.1	140.91 1.1	144.24 1.1	(145) 1.1	150.36 1.2	151.97 1.1	157.25 1.2	158.93 1.1	162.50 1.2	164.93 1.2	167.26 1.2	168.93 1.3	173.04 1.1
Actinium	Thorium	Protactinium	Uranium	Neptunium	Plutonium	Americium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Noiseium
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No
(227) 1.1	232.04 1.3	231.04 1.5	238.03 1.4	(237) 1.4	(244) 1.3	(243) 1.3	(247) 1.3	(247) 1.3	(251) 1.3	(252) 1.3	(257) 1.3	(258) 1.3	(259) 1.3